AMENTMENTS

In The Claim:

Claims 1-11 (canceled)

12. (withdrawn) A method of forming one or more cylindrical bonding structures over a silicon wafer having an active surface and at least one bonding pad on the active surface, comprising the steps of:

forming a ball contact metallic layer over the entire active surface of the silicon wafer, including the bonding pads;

forming a patterned mask layer over the ball contact metallic layer, wherein the first mask layer has at least one opening that corresponds in position to the bonding pad and exposes a portion of the ball contact metallic layer;

depositing conductive material into the opening to form a conductive cylinder over the ball contact metallic layer, wherein the conductive material only partially fills the opening;

depositing solder material into the remaining space of the opening to form at least one cylindrical solder cap on the upper surface of the conductive cylinder, wherein the solder material has a melting point lower than the conductive cylinder material; and

removing the mask layer and the ball contact metallic layer outside the conductive cylinder such that the remaining ball contact metallic layer, the conductive cylinder and the cylindrical solder cap together form the cylindrical bonding structure.

13. (withdrawn) The method of claim 12, wherein the bonding pad is an original bonding pad on the wafer.

14. (withdrawn) The method of claim 12, wherein the wafer further includes a redistribution circuit layer and the bonding pad is a pad on the redistribution circuit layer.

15. (withdrawn) The method of claim 12, wherein after removing the mask layer and a portion of the ball contact metallic layer, further includes conducting a reflow operation to transform the cylindrical solder cap into a solder block.

16. (withdrawn) The method of claim 12, wherein the step of depositing conductive material into the opening includes conducting an electroplating operation.

17. (withdrawn) The method of claim 12, wherein the step of depositing solder material into the opening includes conducting an electroplating or a printing operation.

18. (withdrawn) The method of claim 12, wherein after forming the conductive cylinder but before forming the cylindrical solder cap, further includes forming a transition layer over the upper surface of the conductive cylinder so that the cylindrical solder cap is formed over the transition layer.

19. (withdrawn) The method of claim 18, wherein the transition layer has at least one conductive layer.

20. (withdrawn) The method of claim 12, wherein material forming the conductive cylinder is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

21. (withdrawn) The method of claim 12, wherein material forming the solder block is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

22. (withdrawn) The method of claim 12, wherein material forming the mask layer includes photoresist.

23. (withdrawn) The method of claim 12, wherein the step of forming the patterned mask layer includes forming a photoresist layer over the ball contact metallic layer and patterning the photoresist layer.

24. (withdrawn) The method of claim 23, wherein the step of patterning the photoresist layer includes conducting a photo-exposure and developing the exposed photoresist layer.

25. (withdrawn) A method of forming one or more cylindrical bonding structures over a silicon wafer having an active surface and at least one bonding pad on the active surface, comprising the steps of:

forming a ball contact metallic layer over the entire active surface of the silicon wafer, including the bonding pads;

forming a patterned mask layer over the ball contact metallic layer, wherein the mask layer has at least one opening that corresponds in position to the bonding pad and exposes a portion of the ball contact metallic layer;

depositing conductive material into the opening to form a conductive cylinder over the ball contact metallic layer, wherein the conductive material only partially fills the opening;

removing the mask layer and the ball contact metallic layer outside the conductive cylinder; and

attaching a solder ball onto the upper surface of the conductive cylinder such that the remaining ball contact metallic layer, the conductive cylinder and the solder ball together form the cylindrical bonding structure.

26. (withdrawn) The method of claim 25, wherein the bonding pad is the original bonding pad on the wafer.

27. (withdrawn) The method of claim 25, wherein the wafer further has a redistribution circuit layer and the bonding pads are pads on the redistribution circuit layer.

28. (withdrawn) The method of claim 25, wherein the step of depositing conductive material into the opening includes conducting an electroplating operation.

29. (withdrawn) The method of claim 25, wherein after forming the conductive cylinder but before attaching the solder ball, further includes forming a transition layer on the upper surface of the conductive cylinder so that the solder ball is attached to the transition layer.

30. (withdrawn) The method of claim 29, wherein the transition layer has at least one conductive layer.

31. (withdrawn) The method of claim 25, wherein material forming the conductive cylinder is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

32. (withdrawn) The method of claim 25, wherein material forming the solder ball is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

33. (withdrawn) The method of claim 25, wherein material forming the mask layer includes photoresist.

34. (withdrawn) The method of claim 25, wherein the step of forming the patterned mask layer includes forming a photoresist layer over the ball contact metallic layer and patterning the photoresist layer.

35. (withdrawn) The method of claim 34, wherein the step of patterning the photoresist layer includes conducting a photo-exposure and developing the exposed photoresist layer.

Claims 36-43 (canceled)

44. (withdrawn) A method of forming one or more cylindrical bonding structures over a silicon wafer having an active surface and at least one bonding pad on the active surface, comprising the steps of:

forming a ball contact metallic layer over the entire active surface of the silicon wafer, including the bonding pads;

forming a patterned first mask layer over the ball contact metallic layer, wherein the first mask layer has at least one opening that corresponds in position to the bonding pad and exposes a portion of the ball contact metallic layer;

depositing conductive material into the opening to form a conductive cylinder over the ball contact metallic layer;

forming a patterned second mask layer over the first mask layer, wherein the second mask layer has at least one opening than exposes a portion of the conductive cylinder;

depositing solder material into the opening to form a cylindrical solder cap over the conductive cylinder, wherein the solder material has a melting point lower than the conductive cylinder material; and

removing the first mask layer, the second mask layer and the ball contact metallic layer outside the conductive cylinder such that the remaining ball contact metallic layer, the conductive cylinder and the cylindrical solder cap together form the cylindrical bonding structure.

45. (withdrawn) The method of claim 44, wherein the bonding pad is the original bonding pad on the wafer.

46. (withdrawn) The method of claim 44, wherein the wafer further has a redistribution circuit layer and the bonding pads are pads on the redistribution circuit layer.

47. (withdrawn) The method of claim 44, wherein the step of depositing conductive material into the first mask layer opening includes conducting an electroplating operation.

48. (withdrawn) The method of claim 44, wherein the step of depositing solder material into the second mask layer opening includes conducting an electroplating operation.

49. (withdrawn) The method of claim 44, wherein after forming the conductive cylinder but before the cylindrical solder cap, further includes forming a transition layer on the upper surface of the conductive cylinder so that the cylindrical solder cap is formed over the transition layer.

50. (withdrawn) The method of claim 49, wherein the transition layer has at least one conductive layer.

51. (withdrawn) The method of claim 44, wherein material forming the conductive cylinder is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

52. (withdrawn) The method of claim 44, wherein material forming the solder material is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

53. (withdrawn) The method of claim 44, wherein material forming the first mask layer includes photoresist.

54. (withdrawn) The method of claim 44, wherein the step of forming the patterned first mask layer includes forming a photoresist layer over the ball contact metallic layer and patterning the photoresist layer.

55. (withdrawn) The method of claim 54, wherein the step of patterning the photoresist layer includes conducting a photo-exposure and developing the exposed photoresist layer.

56. (withdrawn) The method of claim 44, wherein material forming the second mask layer includes photoresist.

57. (withdrawn) The method of claim 44, wherein the step of forming the patterned second mask layer includes forming a photoresist layer over the first mask layer and patterning the photoresist layer.

58. (withdrawn) The method of claim 57, wherein the step of patterning the photoresist layer includes conducting a photo-exposure and developing the exposed photoresist layer.

59. (withdrawn) A method of connecting a chip to a substrate to form a flip-chip package, wherein the chip has an active surface having at least a bonding pad thereon, the substrate has a substrate surface having a patterned solder mask and at least one junction pad thereon, and the

solder mask has at least one opening that exposes the junction pad, the method comprising the steps of:

forming a cylindrical bonding structure on the bonding pad of the chip, wherein the cylindrical bonding structure comprises a conductive cylinder and a solder block, the bottom surface of the conductive cylinder is on top of the bonding pad and the bottom surface of the solder block is on the upper surface of the conductive cylinder, and the solder block has a melting point lower than the conductive cylinder;

flipping over the active surface of the chip to face the substrate surface of the substrate such that the upper surface of the solder block contacts the junction pad; and

conducting a reflow process to melt the solder block material so that the conductive cylinder and the junction pad are joined together.

60. (withdrawn) The method of claim 59, wherein the bonding pad is the original bonding pad on the chip.

61. (withdrawn) The method of claim 59, wherein the wafer further has a redistribution circuit layer and the bonding pads are pads on the redistribution circuit layer.

62. (withdrawn) The method of claim 59, wherein material forming the conductive cylinder is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

63. (withdrawn) The method of claim 59, wherein material forming the solder block is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

64. (withdrawn) The method of claim 59, wherein the solder block is a cylindrical solder cap.

65. (withdrawn) The method of claim 64, wherein the cylindrical solder cap has an outer diameter smaller than the opening diameter on the solder mask.

66. (withdrawn) The method of claim 65, wherein the cylindrical solder cap has a length greater than the depth of the opening on the solder mask.

67. (withdrawn) The method of claim 59, wherein the cylindrical bonding structure further includes a ball contact metallic layer between the conductive cylinder and the bonding pad on the chip.

68. (withdrawn) The method of claim 59, wherein the cylindrical bonding structure further includes a transition layer between the conductive cylinder and the solder block.

69. (withdrawn) The method of claim 68, wherein the transition layer has at least a conductive layer.

Claims 70-77 (canceled)

78. (currently amended) A ~~cylindrical~~ bonding structure positioned on a pad of a ~~silicon~~ chip ~~such that the structure may flip over and connect with a substrate~~, wherein the bonding structure is adapted to be bonded on a pad of a substrate, ~~the chip has at least one bonding pad and~~ the substrate has ~~a substrate surface having~~ a patterned solder mask ~~and at least one junction pad thereon~~, and the patterned solder mask layer has at least one ~~an~~ opening that exposes the ~~junction~~ pad of the substrate, the ~~cylindrical~~ bonding structure comprising:

a conductive pillar ~~cylinder~~ positioned over ~~on~~ the ~~bonding~~ pad of the chip; and

~~a transition layer on the conductive cylinder; and~~

a ~~cylindrical~~ solder cap positioned over the conductive pillar ~~on the transition layer~~, wherein the ~~cylindrical~~ solder cap has a transverse dimension ~~an outer diameter~~ smaller than ~~that the diameter of the conductive cylinder and the diameter~~ of the opening in the patterned solder mask, ~~and a length greater than the depth of the opening~~ wherein the solder cap is formed over the conductive pillar before the solder cap is bonded to the pad of the substrate, ~~and the solder material has a melting point lower than the conductive cylinder material~~.

79. (currently amended) The structure of claim 78, wherein the material of the conductive pillar comprises copper. ~~the bonding pad is the original bonding pad on the chip.~~

80. (currently amended) The structure of claim 78, wherein the material of the conductive pillar comprises tin-lead alloy. ~~the chip further includes a redistribution circuit layer and the bonding pad is a pad on the redistribution circuit layer.~~

81. (currently amended) The structure of claim 78, wherein material forming the conductive ~~cylinder~~pillar is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

82. (currently amended) The structure of claim 78, wherein material forming the ~~cylindrical~~ solder cap is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

83. (currently amended) The structure of claim 78, further comprising ~~wherein the structure further includes~~ a ~~ball contact~~ metallic layer positioned between the conductive ~~cylinder~~pillar and the ~~bonding~~ pad of the chip, wherein the material of the metallic layer comprises titanium, tungsten, chromium, copper, nickel, cobalt, silver, gold, tin, vanadium, palladium or an alloy of some of the aforementioned metals.

84. (currently amended) The structure of claim 78, wherein the transverse dimension of the solder cap is smaller than that of the conductive pillar. ~~the transition layer has at least one conductive layer.~~

85. (currently amended) A ~~cylindrical~~ bonding structure positioned on a pad of a chip, ~~such that the structure may flip over and connect with a substrate, wherein the chip has at least one bonding pad and the substrate has a substrate surface having a patterned solder mask and at least one junction pad thereon, and the patterned solder mask layer has at least an opening that exposes the junction pad, the cylindrical bonding structure~~ comprising:

a conductive ~~cylinder~~pillar positioned over ~~on~~ the ~~bonding~~ pad of the chip; and

~~a transition layer on the conductive cylinder; and~~

a ~~cylindrical~~ solder cap positioned over the conductive pillar, the solder cap having a side wall, all of which is exposed, ~~on the transition layer,~~ wherein the ~~cylindrical~~ solder cap has a transverse dimension ~~an outer diameter~~ smaller than the transverse dimension ~~diameter~~ of the conductive ~~cylinder~~pillar. ~~and the diameter of the opening in the patterned solder mask, and the solder material has a melting point lower than the conductive cylinder material.~~

86. (currently amended) The structure of claim 85, wherein the material of the conductive pillar comprises copper. ~~the bonding pad is the original bonding pad on the chip.~~

87. (currently amended) The structure of claim 85, wherein the material of the conductive pillar comprises tin-lead alloy. ~~the chip further includes a redistribution circuit layer and the bonding pad is a pad on the redistribution circuit layer.~~

88. (currently amended) The structure of claim 85, wherein material forming the conductive ~~cylinder~~pillar is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

89. (currently amended) The structure of claim 85, wherein material forming the ~~cylindrical~~ solder cap is selected from a group consisting of tin, lead, copper, gold, silver, zinc, bismuth, magnesium, antimony, indium and an alloy of the aforementioned metals.

90. (currently amended) The structure of claim 85, further comprising ~~wherein the structure further includes~~ a ~~ball contact~~ metallic layer positioned between the conductive ~~cylinder~~pillar and the ~~bonding~~ pad of the chip, wherein the material of the metallic layer comprises titanium, tungsten, chromium, copper, nickel, cobalt, silver, gold, tin, vanadium, palladium or an alloy of some of the aforementioned metals.

91. (currently amended) The structure of claim 85, further comprising a transition layer positioned between the conductive pillar and the solder cap, wherein the transition layer comprises ~~has~~ at least one conductive layer.